Mitsuo SUZUKI* & Kiyotsugu YODA**: **Comparative wood anatomy of *Coriaria* of East Asia** (2)*** ****

鈴木三男*・依田清胤**: 東亜産ドクウツギ属木材の比較解剖 (2)

Discussion Wood structure of four species investigated is fairly homogeneous with each other in respect of elements which constitute the wood, pore arrangement patterns, ray types and some other characteristics. The common characteristics among the four species are summarized as follows: 1) pores are mostly in multiple and solitary pores are rather rare, 2) intervessel pits are alternate and vestured pits are invisible, 3) the perforation is exclusively simple, 4) wood parenchyma is vasicentric and confluent, 5) rays are heterogeneous and very large, and 6) rays occupy a big portion of woods as indicated by about 32-45% in the ray occupation ratio. Most of the common characteristics mentioned above may be regarded to be highly advanced among the dicotyledons except the heterogeneous rays (Carlquist 1961, 1985, Kribs 1937). Highly advanced and fairly homogeneous wood structure within the genus does not support to regard *Coriaria* as "aborigine" with trans-palaeo-equatorial distribution (Maekawa 1960a) or descendant migrated from Gondwanaland (Melville 1966). If one of the two hypotheses is accepted, it would be needed to regard that wood structure of dicotyledons had already fully evolved just after the differentiation of angiosperms in the Mesozoic Era. Such highly advanced anatomical features are observed in many dicotyledons and it would be appropriate to consider that the advanced features have evolved independently in many different taxonomical groups and the features themselves do not seem to indicate direct affinities of Coriariaceae to other taxonomic groups. The heterogeneous ray is usually regarded as one of primitive anatomical features (Kribs 1935, Carlquist 1961). Although rays of *Coriaria* are included within the category

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Tab. 2. Vessel characteristics of *Coriaria* wood.

Specimen Number	Age (year)	Pore density (pores/mm^2) early wood	late wood	Pore number in a multiple	Pore size (μm) tang. × rad. early wood	late wood	Vessel length (μm)	Intervessel pits density (pits/625μm^2)
C. japonica								
9064	1	25-44 (35)	49-87 (69)	1-5(-7)	23-53×30-44[1] (42.9) (58.6)		158-220 (182.6)	13-18 (16)
9245	3	21-39 (29)	20-53 (39)	1-4(-5)	70-142×58-140 (104.7) (87.7)	19-86×17-57 (56.0) (37.6)	68-140 (114.1)	16-21 (18)
9247	3	38-57 (45)	45-61 (51)	2-4	65-120×100-145 (99.1) (123.8)	25-80×30-110 (52.6) (70.5)	110-190 (152.2)	15-17 (16)
9249	3	56-97 (87)	101-129 (114)	2-10	35-63×87-137 (47.5) (109.2)	30-66×65-160 (44.5) (114.6)	120-193 (166.5)	12-18 (16)
9263	4	19-37 (27)	20-30 (26)	2-3(-5)	70-130×120-210 (103.7) (149.6)	35-60×40-90 (44.7) (60.9)	95-150 (117.0)	12-20 (16)
9264	3	34-44 (39)	54-63 (57)	2-3(-5)	50-95×80-145 (75.0) (112.4)	25-50×35-70 (35.6) (52.4)	110-175 (131.0)	11-22 (15)
C. napalensis								
8340004	—	21-33 (28)	22-40 (38)	2-4(-9)	127-235×116-195 (162.5) (156.9)	40-142×34-125 (85.5) (91.7)	83-168 (117.1)	21-29 (25)

8340213	—	21-41 (33)	25-46 (36)	(2-)4-7(-13)	120-200×148-230 (164.5) (188.7)	50-130×45-110 (72.3) (78.2)	98-170 (142.8)	19-25 (21)
8340287	—		24-52[2] (34)	(2-14-15(-20)	140-210×160-240 (162.5) (190.3)	35-120×35-115 (66.5) (69.7)	120-195 (163.7)	22-27 (25)
8340390	—	23-41 (35)	28-67 (50)	2-6(-10)	105-190×135-250 (149.6) (170.6)	35-100×40-110 (62.9) (73.9)	120-183 (154.2)	22-28 (25)
8540009	—	28-41 (33)	51-82 (66)	(3-)4-9(-12)	105-215×125-230 (165.3) (179.3)	35-80×35-105 (62.6) (63.2)	165-240 (200.0)	14-22 (17)
8540010	5	49-62 (54)	74-95 (86)	(3-)4-8(-10)	90-180×115-200 (152.3) (162.5)	30-80×35-80 (49.3) (54.1)	190-260 (220.0)	16-24 (20)
8540016	—	16-26 (21)	26-34 (30)	2-6(-8)	135-220×145-245 (163.7) (185.0)	35-95×35-80 (64.6) (65.2)	130-150 (140.0)	18-27 (22)
C. intermedia								
9322	—	25-31 (28)	39-46 (42)	2-9(-13)	85-140×95-165 (110.7) (124.8)	30-75×30-90 (47.9) (56.3)	110-160 (145.0)	13-18 (16)
C. terminalis								
12316	3	32-52 (45)	41-63 (54)	2-4(-6)	55-110×85-120 (84.5) (100.6)	40-55×35-80 (48.1) (52-8)	115-170 (133.1)	30-36 (33)

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[1] Diffuse porous wood.

[3] In this specimen it is difficult to distinguish clearly early wood pores from late wood ones because of its extremely narrow growth rings.

Tab. 3. Ray characteristics of *Coriaria* wood.

Specimen Number	Age (year)	Ray width		Ray[1] occupation ratio (%)	Ray height		Ray crystal
		(cell)	(μm)		(mm)[2]	excess 6.0 mm[3] (%)	
C. japonica							
9064	1	3-8 (4)	40-100 (62.5)	32.4	0.39-6.47	24.3	−
9245	3	2-9 (6)	30-210 (125.7)	43.0	0.25-4.59	0.7	+
9247	3	4-10 (6)	50-220 (114.0)	—	0.42-4.01	5.2	+
9249	3	2-7 (4)	30-150 (75.3)	—	0.25-5.01	7.2	+
9263	4	5-12 (8)	80-180 (128.8)	39.1	0.16-2.44	0.0	+
9264	3	6-12 (9)	110-160 (131.1)	—	0.19-3.98	0.0	−
C. napalensis							
8340004	—	7-22 (14)	70-420 (241.0)	45.2	0.40-5.35	0.0	++
8340213	—	8-22 (16)	210-480 (291.3)	43.9	0.90-4.59	5.6	+
8340287	—	8-24 (15)	140-480 (291.3)	45.4	0.57-5.00	0.9	++
8340390	—	3-14 (10)	50-240 (178.0)	38.3	0.39-5.19	1.8	++
8540009	—	8-13 (11)	190-270 (230.7)	32.7	0.72-5.18	5.3	+
8540010	5	6-9 (7)	110-170 (135.3)	—	0.33-4.81	22.1	+
8540016	—	15-19 (17)	290-330 (307.6)	35.4	0.46-2.95	0.0	+
C. intermedia							
9322	—	10-14 (12)	170-250 (216.6)	42.1	0.2-3.97	0.0	−
C. terminalis							
123163		8-17 (12)	180-350 (255.8)	40.7	0.38-5.97	4.9	++

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[1] Percentages of the length being occupied by rays along 15 mm horizontal lines on the observed tangential sections.

[2] Height of rays which are entirely included within the observed tangential sections.

[3] Percentages of rays which exceed 6 mm in height in the observed tangential sections.

of the "heterogeneous rays", the origin and nature of these rays seem to be quite different from those of heterogeneous rays of other woody plants, or "pycnoxylic" wood. As described above, these rays are very wide and high and occupy fairly big portions in the wood as observed in manoxylic wood. Such wood with conspicuous rays is usually found in herbs, shrubs or in veins. Therefore, it may be said that *Coriaria* is a "secondarily woody phylad" (Carlquist 1985). In this connection, the efforts to clarify the phylogenetic affinities of Coriariaceae by superficial resemblances of wood anatomical characters among the certain taxonomical groups may often mislead us.

Although the wood structure is very similar in species of *Coriaria*, it is different in some respects as follows: 1) pore size is largest in *C. napalensis* and then larger in *C. intermedia* while smaller in *C. japonica* and *C. terminalis*, 2) pores are arranged mostly in tangential concentric rings with wood parenchyma in *C. napalensis* and *C. intermedia* but in radial and more or less oblique in *C. japonica* and *C. terminalis*, 3) wood parenchyma is most abundant and distinctly storied in *C. napalensis* and a little less abundant and also distinctly storied in *C. intermedia*, while it is less abundant and indistinctly storied in *C. japonica* and *C. terminalis*, 4) intervessel pits are most dense in *C. terminalis*, and then in *C. napalensis*, while they are rather sparse in *C. intermedia* and *C. japonica*, 5) rays are wider and have distinct sheath in *C. napalensis*, while they are narrower and lack the sheath cells in other three species, and 6) crystals are abundant in *C. terminalis*, often present in *C. napalensis*, sometimes present in *C. japonica*, but are invisible in *C. intermedia* (Tab. 2 and 3).

It is known that the wood structure changes gradually according to tree growth because of the aging of the cambium (cf. Carlquist 1961). The wood specimens of the *C. japonica* and *C. terminalis* were collected from only young parts. Most of the terrestrial stems in the former species are two- or three-year-old, because the stems which have grown in the first spring usually bear flowers in the second spring, and then die in the second autumn after producing fruits. At the basal parts of the stem, the cambium is persistent and produces secondary tissue for over two years, but the plant itself dies within several years. In the latter species, all terrestrial stems are one-year-old because the stems die down within the year of its sprouting. Therefore, the stem investigated in the present study is a three-year-old subterranean one. In contrast, the plants of *C. napalensis* and *C. terminalis* are persistent for over ten years and grow taller and thicker. There are some difficulties in the comparison between the wood structure of the very young parts and that of the fairly older parts. For this reason, we examined a young part of *C. napalensis* (No. 8540010) which was collected from a five-year-old shoot of a fairly big plant 5 m tall and 20 cm in trunk diameter (No. 8540009). In this young part, pores are surely a little smaller and rays are narrower than the older part (Tab. 2 and 3), but the features characteristic of this species, i. e., semi-ring porous structure, tangential arrangement of pores, distinctly storied structure and alternate intervessel pitting, are easily recognizable as at the older parts. Furthermore, it may be said in many woody plants that wood structure of the two- or three-year-old plants is fundamentally the same with that of the matured wood except some numerical characteristics, i. e., pore diameter, fiber length, diameter of wood parenchyma, ray width and height, and some others. So that, the comparison of the fundamental wood structure among the specimens examined can be available means for the evolutional and phylogenetic studis of *Coriaria.*

From the discussion in the above paragraph, the wood structure of *C. napalensis* and *C. intermedia* can be considered to be more advanced than that of *C. japonica* and *C. terminalis* because of the presence of semi-ring porous and storied structure, although there are some tendency to be ring porous and storied structure in the latter two species. The former two species are small trees in habit and accumulate rather much amount of secondary wood. Between these two species there is no fundamental difference in their wood structure except the density of intervessel pits, which is usually higher in *C. napalensis* than in *C. intermedia* (Tab. 2). Similarly the latter two species, *C. terminalis* and *C. japonica*, wood structure resembles each other except the density of intervessel pits (Tab. 2 and 3). Although the latter species accumulates much more secondary wood, the alternately and contiguously arranged intervessel pits of the former species are regarded to be more advanced than those of the latter, in which pits are a little sparse and large in horizontal size. Therefore, it may be said that the wood structure of *C. japonica* is more primitive than that of *C. terminalis.*

There are only a few reports on the wood structure of *Coriaria.* Kanehira (1921) described the wood of a shrubby *Coriaria, C. intermedia* Matsum., from Formosa. His description agrees closely with those of most species described in this paper. Wood structure of *C. japonica* was first described by Carlquist

(1985). He studied three New Zealand species and one Japanese species, that is, *C. arborea* Lind. var. *arborea*, *C. ruscifolia* L., *C. thymifolia* Humb. et Bonpl. and *C. japonica* to clarify phylogenetic status of Coriariaceae with ecological implications. The New Zealand species belong to a different group from the Japanese species in the gross morphology (Good 1930). His description on the four species coincides fundamentally with our summarized description of four East Asian species except the fact that his specimens had diffuse porous structure with evident storied small vessels and axial parenchyma. Because he did not describe fully the age, size and habit of the examined plants, we can not presume the structural change according to the age. Inferring from the description and photographs in his paper, it is understandable that they are almost diffuse porous and *C. arborea* has distinct storied structure, while the structure is rather indistinct in *C. japonica* and *C. ruscifolia*. Therefore, it may be said that *C. arborea* with tree habit has the most advanced wood structure just like in *C. napalensis* and *C. terminalis*, while the other three species with shrubby habit have less advanced ones.

We studied representatives of two groups of Good (1930) in the present paper: *C. terminalis* belongs to the one and *C. napalensis*, *C. intermedia* and *C. japonica* to the other group. With regard to his grouping, we find that the wood structure of *C. napalensis* and *C. intermedia* is more advanced and that of *C. japonica* is the most primitive within the four species studied. As mentioned previously, *C. napalensis* and *C. intermedia* are small trees and *C. japonica* is typically shrubby, while *C. terminalis* has a prominent habit, that is woody perennial herb. Judging from the observation by Carlquist (1985), the arboreal species, *C. arborea*, has also the most advanced wood among three New Zealand species. Therefore, it may be suggested that the wood structure in *Coriaria* has differentiated into two directions from a wood with the diffuse porous, indistinctly storied structure with sparsely distributed intervessel pits. One direction is represented by a wood with semi-ring porous and distinct storied structure with contiguous intervessel pits, which seems to be correlated to the ecological habit from shrubby type to tree type with acquirement of persistent cambial activity. The other direction is found in *C. terminalis*, in which the wood also gained the contiguous intervessel pitting and the habit changed from shrubby type to herbaceous type by the acquisition of annual terrestrial shoots with terminate inflorescences. It is difficult at present to decide which is more plausible that the wood structures in the East Asian species and in the New Zealand species have independently evolved in parallel within those two areas, or the East Asian species and the New Zealand species have evolved from the same ancestral stock and then migrated in fairly separated two areas. As Carlquist (1985) pointed out, more extensive and precise studies are needed for clarifying the phylogeny of *Coriaria*. Developmental wood anatomy on representatives of all other areas is also strongly required.

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ドクウツギ属は世界に約20種あり，地中海，日本からヒマラヤにかけての東亜，ニューカレドニアからニュージーランド，そして中米から南米チリと大きく四つのかけはなれた地域に隔離分布していることで有名である。この分布をもとに前川（1960a）は古赤道説を打ち立て，Merville（1966）はゴンドワナ大陸の大陸移動とそれにうち続く移住によって説明した。Good（1930）は外部形態からこの属を3つのグループに分けた。それによるとAグループはヒマラヤ特産の *Coriaria terminalis* 一種で代表され，大きな頂生する総状花序と一年性の地上茎でほかのものとはかけ離れた形態を示す。Bグループは地中海から東亜に約8種があり腋生の花序がその基部に鱗片を持つことで，またCグループは南半球中心に約12種があり，腋生の花序は鱗片を持たないことで特徴づけられている。

この研究では東亜産の4種の木材組織の比較解剖を行い，これらの木材組織の被子植物における進化程度とグループ内における類縁関係を明らかにしようと試みた。用いた試料は *Coriaria japonica*（ドクウツギ），*C. napalensis*, *C. intermedia*, *C. terminalis* の4種である。この前3種はBグループに，最後の1種はAグループに属する。ドクウツギは石川県手取川流域で採集したものを用い，*C. napalensis* は東京大学のヒマラヤ植物調査（1983, 1985）の折りにネパールで採集したものを用い，*C. intermedia* は大阪市立大学の能城修一氏らが台湾で採集したものの提供を受け，*C. terminalis* は東京大学総合研究資料館所蔵のさく葉標本から得た。

比較解剖の結果，これら東亜のドクウツギ類はたがいに良く似た材構造で，散孔性から半環孔性の道管配列を示し，道管穿孔は単一，道管相互の壁孔は交互状，柔組織は周囲状から連合翼状，小道管の柔組織は極めて明快なあるいはやや明快な層階状構造を示し，放射組織は極めて大型で背が高い異性などの，放射組織を除いては極めて進化した形質を多く持っていることが明らかになった。これらのことから前川や Merville らの言うように中生代に現在の分布の祖形があるとするとこのような高度に進化した材構造が中生代には既に一般的であったと考えなければならず，化石の資料とはうまくあわない。一方，ドクウツギ科はムクロジ目に入れられることが一般的であるが，またそれと異なった意見が幾つかある。材構造からはこれらの類縁関係を直接示唆する結果は得られなかった。ニュージーランドと日本のドクウツギの比較材解剖を行った Carlquist（1985）も指摘しているように，放射組織の形態が通常の高木になるものとは異なり，さらにそ

れの材内で占める量が大きいことなどから，むしろ二次的な木本植物である可能性が考えられた。さらに詳細な材組織の比較から低木である日本のドクウツギのタイプから *C. napalensis* や *C. intermedia* の高木のタイプへのより永続性のある形成層の獲得による進化と，日本のタイプから *C. terminalis* のタイプへの草本化による進化が考えられた。これは Carlquist が報告したニュージーランドの種類でも可能性が考えられるが，生育環境に適応した結果としての平行進化の結果なのか，両地域のドクウツギが同じ祖先から由来した結果なのかは現時点では分からない。

□佐川　昇：**山形県内陸地方産シダ植物図集** 180 pp. 1986. 山形. ¥2,000. 山形県の内陸地方というのは出羽山丘陵と奥羽山脈とに狭まれた，県の大部分を占める地域で，最上川の流域に当たっている。著者は山形市に住む熱心なシダ研究家で，今まで新産地や新雑種をたくさん発見しているが，この10年間に描きためたシダの線画の中から152枚を選んで図集にしたという。B5判の頁一ぱいに1種ずつの図は，細密なだけでなく特徴をよく出していて，著者の知識の確実さを物語っている。初めに同地方のシダ植物目録167種（内雑種24）が産地入りで載っているが，その中でワラビなどごく普通の種類を省き，代りに多形な種類には2枚を用意している。また31枚の雑種は専門家にとっても大変参考になる。著者の宛先は山形市東原町 3-8-13。　（伊藤　洋）

□Lellinger, D. B.: **A field manual of the ferns & fern-allies of the United States & Canada** 389＋図版 45 pp. 1985. Smithsonian Institution Press, Washington, D. C. $31.45. ハワイを除いたアメリカ合衆国とカナダに産するシダ植物を解説した手引書で，研究者とアマチュア愛好者の両方をねらったものである。著者はスミソニアン自然史博物館で活躍中のシダ学者で，特に熱帯アメリカに詳しい方である。取扱ったシダは亜種・変種を勘定に入れて406種類で，各種類ごとの学名・英語名・形態の記載・生態・分布・栽培法などと，各属から種へ，各科から属へなどの検索表が本文の大部分を占めている。わかりやすく書かれているが，説明図のようなものはほとんどない。その代りにカラー写真402個からなる図版が光っている。これはテネシー大学の A. M. Evans 教授が分担したそうで，アラスカからフロリダまで飛び回って撮影したという。それぞれの種類によって生態写真・接写・葉裏の拡大などが使い分けられていて特徴がよく出ている。初心者向けにシダの集め方や観察の仕方などの説明，用語の解説などがあり，どれもよくできている。専門家にとって興味深いのは巻末の雑種複合体という項目で，*Asplenium, Dryopteris, Isoetes, Lycopodium, Polystichum* などの雑種についてのアメリカにおける実例が模式図入りで説明されている。　（伊藤　洋）